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ILLUMINATION OF AIRWAYS AND LANDING FIELDS

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## ILLUMINATION OF AIRWAYS AND LANDING FIELDS.\*

By paul stadthagen, Charlottenburg.

How to attain high speed of flight, together with favorable fuel economy, notwithstanding great carrying capacity for useful load or comfortable transportation of passengers, and great safety in landing through low landing speed combined with undiminished stability, is the problem at which the modern aircraft designer in this and foreign countries, is industriously working. After the experience of several years of war-time flying, and, above all, of the recent beginnings of passenger and mail transport by air, we want to produce the weatherproof commercial airplane, safe in operation for day and night flying. The technical and general press follows with interest the steady development of the newly appearing types of airplanes.

And nevertheless there is for commercial flying another problem at least equally important, that is, the ground organization, which up to now has always been kept in the background, since it apparently only eats up money, and the actual gains do not stand out correspondingly. The unlimited confidence which passengers as well as the postal administration ought to have in air transport, can only arise and be kept by the working together of first-class aircraft material and transport organization which functions safely. The aircraft which is beyond criticism, from a technical point of view, must be so protected by a signal system and the construction of landing fields that, as far as man can foresee,

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\* Translated from "Der Luftweg," April 21, 1931, No.15/16, pp. 117-119.

accidents which usually arise from loss of orientation and consequent forced landing on unfamiliar terrain, are avoided. Only after the exclusion of these possibilities of loss in time and material can the air transport companies guarantee compliance with plans as laid down. The best advertisement for flying would be its safety, for as soon as the public notices that all conceivable precautions have been taken for the protection of the health and lives of the aircraft crew, then finally flying will become popular ..... a main channel to profitability.

To the ground organization belongs a quickly broadcasting weather service (wireless telegraph) built up on international lines. Even though the airplane becomes more and more independent of bad weather, nevertheless, especially for the evening hours and night, an actual forecast of dangerous weather, which, for example, warns of approaching fog, heavy precipitation, or storm, would have its influence on the flying program.

One may note a tendency, understandable on economic grounds, for air transport companies to eliminate the observer (person familiar with the country, or guide) who is responsible for the orientation, as soon as a flying route has been covered so often by the same pilot that he can find the way alone. A conscientious undertaking must concede in this connection that with this system, in which a certain strain on the attention of the airplane pilot continually enters, a continuous marking of the route becomes necessary as a mental relief to the pilot and also in order to ensure the completion of the flight, even under unfavorable conditions,

as, for example, bad weather.

With the corresponding development of flying, as with all other means of transportation, it will matter less and less whether we fly by day, evening, or night.

With this I come to the matter of ground organization for night flying, in which direction much has been planned, and many tests made. There have been referred to this the regulations laid down in the "International Convention for Air Navigation," in the "Rules for Air Traffic on and in the Neighborhood of Airdromes," respectively, under the "System for Ground Markings". Since German air traffic also is to adhere to these regulations, they can and will not logically be blamed if they, on the basis of their knowledge and experience, make proposals on their part, where they consider improvements possible for the essential requirements of air navigation.

In case the low visibility at night no longer permits the aviator to orient himself by the map, or to hold his course by calculating specific speed, wind velocity, and wind direction, there still remains to him the possibility of fixing the location directly under him by taking bearings from stations by wireless telegraph. Airships, and giant and large airplanes, which were equipped for it with wireless apparatus, still heavy and expensive, have already used this often successfully in war over land and sea. The optical guide in the form of a system of signal lights will remain for the present, however, the chief aid to ready orientation for air traffic by night.

The illumination of air traffic routes must be handled as simply as possible, not indeed only to avoid expense - costly arrangements can positively pay for themselves - but on the contrary, to remain operative without confusing the necessary concentration of night flyers because of complication in the lighting arrangements or an excess of light signals.

If we distinguish between the optical aids which are necessary to obtain "major orientation" and such as enable the route to be followed from place to place along the way, then the latter are points of the second class.

Major orientation is important for flyers unfamiliar with the country, coming from a great distance and, also in weather of really low visibility, as the last stop for the professional commercial flyer following the route. For this the strongest and most conspicuous signal lights come into consideration. They are to be put in operation only near the few flying centers and the most important geographical points on the flying routes, by which means a confusing, too close marking by lights is avoided. Two kinds of illumination, side by side, are to be recommended for the ready designation of these points of the first class.

I. Arrangements of intermittent lights in fixed beacons flashing according to a Morse code                      These flashing lights work continuously at short intervals, in order to bring out the distinctness of the momentary beacon. They are to be mounted on supports like a lighthouse, in order to attain as great

a radius of action as possible. Their luminosity will suffice in practice if a night-flying aviator midway between two beacons can recognize both under conditions of normal visibility. (Beacons with a radius of action of about 80 km. (50 mi.) were in operation during the war.) As already mentioned above, the visibility of even these powerful signal lights is dependent on the state of the weather; since the formation of clouds and fog obscures the action of the light, even to the point of invisibility in case it is completely blanketed by clouds. Therefore, in my opinion, expense for major orientation must not be spared. Immediately beside these signal lights so-called luminous tracer shell guns are to be stationed, which have proved themselves good in the field. These signal guns have been perfected from signal rockets; they are small rapid-firing guns, which shoot luminous projectiles some thousand meters high. Since they penetrate through layers of cloud, these luminous shells always give a reliable signal for the night flyer. They must be fired, according to the degree of lack of visibility of the night, at intervals of two to five minutes, in the same code as that of the corresponding intermittent light (for example, intermittent light -, - - equivalent to shots from the signal gun: 1st shot, pause, 2nd and third shots). Since these signal guns, in order to avoid unnecessary expense, will be put in operation only when the bad state of the weather over the stretch of route concerned demands it, it is a warning signal for the aviator on his way, if he - perhaps while still flying along without worry over a cloudless region - sees in the distance, in-

stead of the intermittent light, the conspicuous appearance of the luminous shells sweeping through the air. For night flying a minimum flying altitude will be established for the safety of passengers in case of breakdown occurring in the airplane, as well as also especially to avoid disturbing the rest of inhabitants on the ground. Constrained by this, the night flyer will not be permitted to fly along under the cloud blanket to facilitate his orientation, as, for example, in war, and thus will the more often refer to the penetrating luminous guides of the signal guns. The determination of a minimum flying altitude is better suited to the purpose and cheaper for the ground organization than the placing of warning signs on the roofs of hospitals, schools, etc., as American cities are planning. The signal guns also come into operation in case of failure of the source of light for the intermittent lights, and thus also the safety of operation is increased in the supplement; intermittent lights plus signal guns.

After major orientation has been assured, and also is independent of the weather, by identification marks of this kind, we come to the optical signals, which in normal circumstances are to identify smaller stations on the airway. For these points of the second order, steady luminous signals, such as lamps and small searchlights, will come into consideration. Since we are calculating on the basis of well-trained pilots, I do not favor projects according to which the air route is closely beset with signal lights, in order that the flyer may not indeed deviate to the

right or left. With the "continuous marking," specified by me at the start, as the reliance of the aircraft pilot who is exclusively responsible, I do not mean at all a dense accumulation of signals, which is entirely too costly, and extends far beyond the requirements in practice. A corresponding statement holds for the illumination of points of the second order, which is even visible at considerable distances, like daylight signals. In really bad weather it must suffice to be able to direct oneself by the always visible luminous beacons of the major orientation system. Under normal weather conditions, that is, in moonlight, as also in dark but clear or only lightly overcast nights, one can nevertheless, as in daylight, keep to ground orientation, as, for example, river courses, highways, the form of the edges of woods, lighted cities and railway stations stand out as conspicuous guides. It is accordingly not absolutely essential in what manner the night ground marking for these points of the second order is arranged. Obviously, a uniform system must be employed also for this more subordinate means of assistance. For one thing, it would be conceivable to make the identification marks to be laid out, notwithstanding, for day flying - according to the International Convention for Air Navigation, section II, par. 1 - recognizable at night by illuminating them (figures and rectangles by means of little lamps mounted upon or in them or surfaces illuminated by searchlights). Alternatively a system of marks, likewise steadily illuminated, of large area, such as crosses, circles, or other geometric figures, each determined for a designated route, may



find employment. The use of names of places printed out has not proved itself especially satisfactory. Finally, the lights of the airport offer a slight assistance; at least, for the flyer always covering the same route.

With this I come to the illumination of landing fields. Fields for night flying are identical with those used in day flying operations, but only the largest or most favorably located are used as regular night landing fields; the others, as emergency landing fields. Obstructions, such as trees, high tension wires, telegraph poles, and so on, must be absolutely eliminated by moving them, in case they would be in the way of an airplane coming in to land or "hovering" - the last stage of a flat glide. Marking such obstacles even by red lamps does not correspond to the requirements, since the aviator may simply become confused by the lights, and, on the other hand, frequently is absolutely unable to fly above these warning lights, if he is to set down in the proper place in landing. The night airports will always be looked for near the important places and so will lie in the neighborhood of the intermittent lights, together with the steadily lighted beacons. Obviously, placing these signal lights close to or upon the flying field must be avoided, for it is impossible for any aviator after his eyes have become accustomed to the darkness of the night to land in the blinding glare of these signals.

Instead of using the generally known T-shaped landing cross, the place on which a landing into the wind can be made is designated by lamps (Fig. 1). Making a landing between two white lights

toward a red light is the simplest landing system, one which has proved itself practical in countless night landings. In this the pilot must endeavor, while heading toward the red light, to set the airplane down at least between the white lights, in order to have stopped rolling at the latest at the red light. An indication for the horizontal direction is given by the two lamps erected so as to form a gate; the third, red lamp - which, for setting an exact, straight course can be brought in line with a green lamp set up at a short distance behind it - shows the longitudinal direction of the landing run. Assistance in landing is afforded by illuminating the landing run, in the direction of landing, with a searchlight, which is erected near one of the white lamps and is turned on only when an airplane has set down for landing. The same purpose, namely, recognizing the ground itself, as well as also in this case, the distance from the ground is served by the use of special airplane searchlights (so called footlights) under or in the leading edge of the lower wing. They likewise illuminate the ground and make it possible for the eye, as in daylight, to judge the right moment for shutting off. Completely leveled landing fields are a preliminary condition for this, in order not to subject the aviator landing at night to disagreeable surprises in the form of dangerous rises or descents. Where altimeters and even ground indicators long since no longer work accurately enough, with either of the two arrangements described above sufficient assistance is given to the eye in darkness for determining the vertical direction.

By the use of outboard illumination, as well as also with the help of luminous rockets fired from the airplane, smooth landings have been made even on fields without lighting arrangements. In preparation for a forced landing from a considerable flying altitude the night-flying aviator is further able to avail himself of an additional factor of safety, the parachute flare. This proved its worth well in the war on the side of friend and foe in seeking out bomb targets, positions, etc. In use the parachute flare is to be thrown overboard, and may be so adjusted before launching that it will begin to light up the ground only at the desired height, for example, 400 m. (1300 ft.). Since it floats down very slowly when the parachute has unfolded, it lights up the surroundings over a wide area for several minutes, so that the aviator has an opportunity to look for the most favorable place for a landing.

The three or four landing lights will burn continuously on much frequented flying fields, and will be extinguished only for short intervals, in order to make impossible a simultaneous landing by the next airplane, in case one is still rolling in the landing stretch. The order of landing is generally regulated by a blinker call from the airplane and a blinker answer from the field. The lighting installation is also used in taking off. On large flying fields a second installation is possible for this, parallel to the landing run, which in case of necessity, is used as a substitute landing equipment. The lamps must be easily portable, in order to make possible a change in position becoming necessary be-

cause of a change in the wind direction or some other circumstance. Emergency landing fields, and smaller fields, seldom visited, which are not continuously lighted, should turn on the landing lights at least on a luminous signal from an airplane requesting it; signal lamps, pistols with luminous cartridges of different colors, and rockets must be on hand. One man as lookout is enough for this attendance, which only is necessary, as well as for discharging a luminous rocket, if possibly in a storm an airplane is heard flying toward the field, or it has made a red light signal, an indication of pressing need for an opportunity to land.

If heavy traffic on future night landing fields unavoidably involves a confusing excess of illumination from automobile headlights; lighting of airplanes in landing, etc., and, further, the design of future commercial airplanes does not afford to the pilot, as hitherto, an unobstructed field of vision downward, then only might the arrangement of landing lights described, no longer suffice. Use must be made of unmistakable luminous signals for ground markers, such as we have, for example, in the patented "Honig Circles" (Fig. 2). This apparatus fulfills the requirements for the determination of the transverse and lengthwise directions, as well as vertical distance from the ground, and is said to make possible a landing in a determined mechanical manner, to the complete exclusion of an estimate by the senses, which will soon be very uncongenial to most modern aviators. It is advantageous that landings with these circles can be made for practice in daylight.

With the help of the simple arrangements cited above for the illumination of airways and landing fields, it is now possible to entrust to every aviator, who on his pilot's examination has, in addition, been tested for possible night or color blindness, the responsibility for keeping the flying course and making smooth landings also at night.

How real the question of ground organization for night flying has already become, is shown by the reports of the American air mail service, which is known to be well developed. Here the idea is being considered of shortening the time in transit by establishing a regular night air mail service - at first running over level country - while up to now a mixed system has been employed: By day the mail was carried by air, in the evening loaded on connecting night express trains, so as again to reach its destination next morning by airplane. Already the first record performances of the air mail, flying at night without using the railway have been made, and a series of beacon fires for aviators to use in orienting themselves by night is said to have been arranged. Further in the contest for the "Grand Prix de l'Aero Club de France," a Farman-Goliath flew in the night under difficult conditions, because marks for night orientation, which would have facilitated holding the course, were lacking.

Since night flying operations have a justification for existence as an important force for making air transport economical and capable of meeting competition, we shall finally come to a

detailed improvement of the ground organization. We are now in a position to make this so satisfactory that the air transport companies will be able to send any one of their pilots over the route without anxiety, and not, as hitherto, be obliged to employ only the few pilots acknowledged to be most capable.

I believe that I have shown a simple method for the practical solution of the problem of the "Illumination of Air Traffic Routes and Landing Fields," in contrast to the projects, mostly of theoretical interest, hitherto customary. My proposals are based, as is essential in this subject, upon my own experience and expert knowledge, as I have made night flights for a long time as an airplane pilot, and in this regard have been able to make satisfactory observations. This discussion will have fully attained its purpose, if experts of the air transport systems and the industry, stimulated by my realization of the plan, take an attitude on the question of the illumination of air traffic routes and landing fields, in order thus to contribute to the development of this field of ground organization for night flying.

Translated by the Wright Aeronautical Corporation, Paterson, N.J.

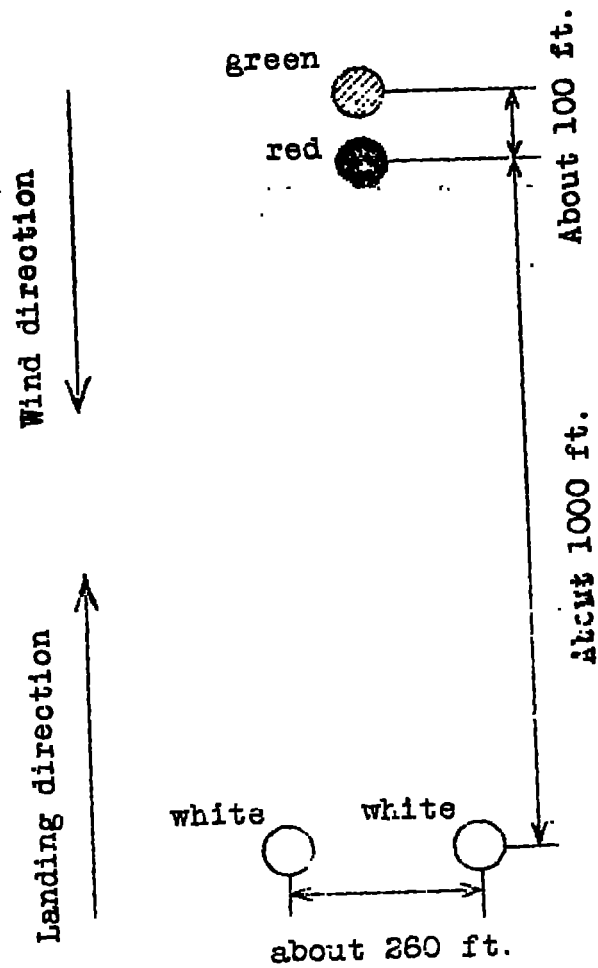


Fig. 1. Arrangement of landing lights.

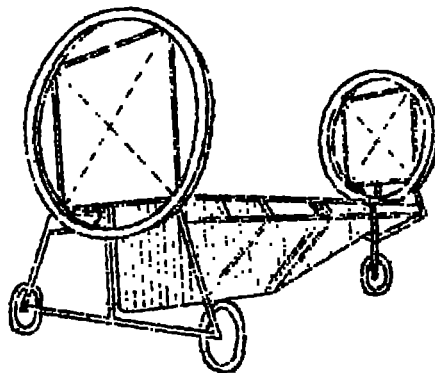


Fig. 2. Honig circles.